Hulihe'e Palace – Assessment of Earthquake Damage 23 October 2006

An assessment of Hulihee Palace was done by Glenn Mason and Katie Slocumb, historic architects, and Afaq Sarwar, a structural engineer, to evaluate damage to the structure and finishes resulting from the 15 October 2006 earthquakes. The initial earthquake was assigned a 6.7 on the Richter scale. It was followed by a magnitude 6.0 quake located off the Kohala coast, about 7 minutes later.

Background

Hulihee Palace was built in 1838 of basalt field stones mortared together with a lime mortar using local beach sand. The beach sand used is primarily coralline in nature, but with a significant amount of finely pulverized basalt sand. The lime was made from burning coral on the site.

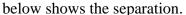
Historic photographs indicate that the corners were formed of larger stones, flattened and interwoven to tie the corners together better. In other areas of the walls the stones used are more likely to be smaller and of irregular shape. The walls are almost 3 feet thick, although the gable ends, from the sills of the attic windows, appear to be about 2 feet thick.

In 1886 King Kalakaua renovated the building for his personal use. At that time the makai lanai were rebuilt and enlarged, the exterior walls plastered, the interior walls replastered, and the roof over the Kau door was redone, among other things. Most of the hand-hewn Ohia floor and ceiling framing of the original construction of the building was reused and remains today.

The roof framing is modern and apparently dates from the 1928 restoration of the building, with some later repairs made in a 1970's restoration effort. The later period work installed some steel connectors that tied the trusses to the wood plate at the top of the walls. The trusses were tied to the three Ohia beams that run the length of the house, into which the ceiling joists are notched. At the gable ends, the ceiling beams run into another 7 ½-inch Ohia beam that is embedded in the wall. This beam effectively acts to reduce the masonry continuity between the gable and the walls below, by reducing the stone wall thickness at its location. A similar condition occurs just below the first floor joists, but the stone walls are thicker at this location. In all locations these beams appear to be in good condition.

Observations of Damage

The building is generally stable. One condition was noted in the attic, at the Ka'u-facing gable, where the stone wall has split apart, separating from the exterior wythe of stone by as much as 8 inches above the window and leaning into the attic. The figure on the right







This was stabilized by installing braces under the wood lintel to the stone and ceiling framing below to prevent any collapse.

Exterior:

There is significant damage to the cement plaster finishes particularly on the two gable ends of the building. At the Ka'u end, this has caused large areas of the plaster to loose adhesion with the stone wall substrate. Some of that has fallen off, but much is still in place, hanging from the surface.





When the building movement occurred, the roof over the Kau entry was pushed outward and is out of plumb by about 3 inches. The posts and pilasters are correspondingly leaning.

Individual stones do not appear displaced except at the gables. At both gables, it appears that the wall section between the two attic windows, from approximately the line of the attic window sills to the peak of the gable, is "pushed in" toward the attic, causing a lean that is up to 4 inches as one nears the roof.

The long sides of the house are cracked, with some plaster damage, although not as bad as the ends. On the makai side, it appears that the entire wall was moved outward and remains about ¾-inch bowed out at the second floor line. This has caused several areas of damage to the wall plaster just under the lanai ceiling.

Interior: That same movement described above caused damage to cornice moldings at the first floor ceiling and separations between the interior framed cross walls and the exterior walls.



Missing cornice molding, second floor



Crack in interior frame wall as it abuts exterior



Missing cornice molding, loose picture molding



Exterior wall, plaster pushed out at ceiling

The ceilings of the first floor are relatively intact but cornice moldings and picture moldings are damaged or cracked in both end rooms. The second floor has similar damage patterns, but much more damage at the ceilings and to the picture moldings. The ceiling plaster was popped off the wood lath by compression forces across the ceiling plane. For the most part, the wood lath remains attached to the ceiling joists. The wood lath itself, the backs of which seem to have been saturated with creosote or some other dark material, are in good condition.





Ceiling plaster damage at second floor

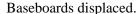
Ceiling plaster damage at first floor

The movement of the second floor followed the makai wall, effectively pulling the joists in that direction. This has opened up a gap between the ceiling and wall at the second floor. Investigations showed, however, that the ceiling joists still had ample bearing on the walls, so structural stability was not compromised.

There is a ¾-inch wide gap in the flooring at the makai door to the lanai from the second floor. Since the flooring at the door opening is attached to wood blocks in the masonry wall, and the room flooring is attached to the floor joists, this indicates that the center section of the makai wall moved out by that much. The outward movement appears to reduce to almost zero as one gets closer and closer to the gable ends walls.

The building movement caused a lot of movement in the woodwork in the Palace, causing some of the original wood to be displaced, and in some cases, cracked.







Crack at first floor carries up wall and through the window casing trim. This is an example of a window that will need to be taken apart and reconstructed.

The roofing and roof structure, the exterior makai lanai, and the newly reconstructed Kitchen, appear to be in good condition.

Summary and Recommendations

The Palace appears to be structurally stable. However, another seismic event of similar magnitude could pose threats of collapse of the gable ends and perhaps, portions of the second floor walls. Until repairs to the building are made, it is recommended by Afaq Sarwar, structural engineer, and this author, that access to the public be limited to the center room at the first floor and the makai first floor lanai. Access to the other rooms in the Palace should be restricted to staff and workmen. Although the building has been "red tagged" by inspectors, this was done on the basis of a fairly cursory examination. We recommend that the hazard designation be changed to yellow tag.

We have several short term and long term recommendations regarding the treatment of the building:

Immediate:

- Due to the loose plaster on the Ka'u side, cordon off the area all around the Ka'u end, from the bottom step of the entry in a straight line, to keep people away from that side of the building.
- Clean the dust and sand particles from all surfaces in the building to avoid damage to surfaces from the tracking around of the plaster aggregates.
- Brace the Ka'u entry roof structure until it is repaired.

Within the next few weeks

- Remove all loose plaster from the Kau' end wall.
- Remove any hanging plaster from the ceilings inside the Palace.
- Perform tests on the original mortar to verify strength and composition.
- Prepare drawings for obtaining proposals for the repairs and approvals from reviewing authorities, including FEMA, the State Historic Preservation Division, State Parks and the County.

Repair Phase

- Demolish and rebuild the gable end walls between the windows, as appropriate to bring them to plumb. Use existing stones to rebuild the walls, and a lime plaster mix of week enough consistency to match the rest of the walls.
- Remove all plaster from the Ka'u end and replaster that end of the building. Install plaster with lightly incised scoring lines to match the Kalakaua-era plaster of the building.
- Remove loose exterior plaster on the Kohala end wall. It should be assumed that nearly all of the plaster will need to be replaced at that end as well.
- On other exterior elevations, remove any additional loose plaster and install new plaster. Match existing textures. Assume 10% of the exterior plaster on the mauka and makai walls.
- After removal of loose plaster around Kau entry roof, remove flashing and roofing adjacent to the wall, investigate connections to wall and straighten the structure.
- Retain all wood lath, verifying attachment to joists.
- Make all ornamental plaster repairs.
- Reattach picture moldings. Assume 15% of picture molding (they are a gold lacquered silver leaf) will have to be refinished due to damage.
- Remove selected areas of interior flat plaster, adjust furring if required, and install new plaster. Patch all small cracks.
- Make repairs to miscellaneous wood work items. In many cases this will involve carefully taking apart the wood window surrounds, repairing wood items and

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reinstalling the trims. Each step of this process should be carefully monitored and recorded.

• Repaint all plastered walls and ceilings.

Estimated Costs

The costs to make the repairs indicated above are preliminary and will require more detailed investigations to verify. The costs for this work are influenced by the following factors:

- 1. The already overheated construction economy on the island of Hawaii.
- 2. The need for some skills, such as ornamental plastering, that do not appear to exist in Hawaii.
- 3. The need for highly skilled craftsmen to make some of the repairs, such as those on the window surrounds.

It is estimated that the repairs to Hulihee Palace will cost between \$900,000 and \$1,100,000. Detailed estimates shall be prepared within the next few weeks.

Respectfully submitted,

Glenn Mason, AIA President